

TAXODIOMERIA (TAXODIACEAE), AN INTERGENERIC
HYBRID BETWEEN TAXODIUM AND CRYPTOMERIA
FROM SHANGHAI, PEOPLE'S REPUBLIC OF CHINA

Zhang Jian-Jun¹

Shanghai Academy of Agricultural
Sciences, Shanghai 210006
People's Republic of China

Zhu Jian-Hua

Shanghai Seed Industry Company
Ltd., Shanghai 200233
People's Republic of China

Pan Shi-Hua, Zhu Wei-Jie
Niu Hui-Juan, and Ye Zheng-Ji

Shanghai Forestry Station,
Shanghai 200072
People's Republic of China

Hsu Ping-Sheng¹

Institute of Biodiversity
Science, Fudan University
Shanghai 200433
People's Republic of China

ABSTRACT

We describe in this paper the hybrid genus \times *Taxodiomeria* Z.J. Ye, J.J. Zhang et S.H. Pan, gen. nov. (*Taxodium* Rich. \times *Cryptomeria* D. Don) and the hybrid species \times *T. peizhongii* Z.J. Ye, J.J. Zhang et S.H. Pan, sp. nov. (*Taxodium mucronatum* Ten. \times *Cryptomeria fortunei* Hooibrenk ex Otto et Dietr.) (Taxodiaceae). The hybrid originated in Nanjing in 1963 and was introduced into Shanghai in 1975; it has been propagated vegetatively since then. These hybrids, about 2000 in all, were hardly known but are now big trees and highly valued for their fine shape, faster growth rate, and adaptation to urban environments compared to *Taxodium* and *Metasequoia*. Morphologically, the hybrid species strongly resembles *Taxodium mucronatum*, differing slightly in a few vegetative characteristics.

ABSTRACT (CHINESE)

本文对杂交属 *Taxodiomeria* Z.J. Ye, J.J. Zhang et S.H. Pan, gen. nov. (*Taxodium* Rich. \times *Cryptomeria* D. Don) 和杂交种 *T. peizhongii* Z.J. Ye, J.J. Zhang et S.H. Pan, sp. nov. (*Taxodium mucronatum* Ten. \times *Cryptomeria fortunei* Hooibrenk ex Otto et Dietr.) (Taxodiaceae) 作了描述。该杂种 1963 年在南京杂交成功, 1975 年引入上海, 并进行无性繁殖, 现有大树约 2000 株。这些杂种过去鲜为人知, 但如今因其树形美观, 生长速度快于落羽杉属 (*Taxodium*) 和水杉属 (*Metasequoia*) 树种且更能适应城市环境, 而受到高度重视。该杂种在形态上与墨西哥落羽杉 (*Taxodium mucronatum*) 很相似, 但在一些营养体特征上与后者有差异。

A new intergeneric hybrid *Taxodiomeria peizhongii* Z.J. Ye, J.J. Zhang et S.H. Pan of Taxodiaceae, described below, arose from a cross between *Taxodium mucronatum* Ten. (♀) and *Cryptomeria fortunei* Hooibrenk ex Otto et Dietr. (♂). It is said that a number of individuals of *Taxodium mucronatum* were introduced into China around 1925, but now only two were found living. One was on the campus of Dongnan University of Nanjing, the maternal plant of the hybrid species. *Cryptomeria fortunei*, a native of southeastern China, is widely

¹ Authors for correspondence: Zhang Jian-Jun, zjjun071416@yahoo.com.cn; Hsu Ping-Sheng, pshsu@fudan.edu.cn.

cultivated in the area south of the Yangtze River, but the paternal tree of the hybrids has not been found. The hybrid cross was made in Nanjing in 1963 by the late Prof. Ye Pei-Zhong, a prominent botanist specializing in the cross-breeding of trees. Finally he was able to produce three cones and a number of hybrid seedlings, but only five of the 12 F₁ seedlings survived (Anonymous 1979; Miao et al. 1982). About 6000 cuttings were prepared in successive years up until 1972. Some of these were introduced to Shanghai, Hangzhou, Wuhan, and other cities in China. It seems that the hybrid saplings had not shown any valuable silvicultural characteristics superior to the related species of *Taxodium*, *Metasequoia*, and *Cryptomeria*. Therefore, they did not excite much interest among dendrologists in Nanjing. This is probably why there are only a limited number of hybrid trees growing there today.

Some 260 hybrid saplings were introduced into Shanghai for the first time in 1975 under the supervision of professors Cheng Xu-Ke and Jin Guo-Pei. From 1975 to 1983, thousands of young plants were propagated vegetatively from these saplings in the tree nurseries of Songjiang and Yangjing while Ye Zheng-Ji, the fifth author of this paper, was in charge of the work of cultivation and propagation of the hybrids in Songjiang. However, for lack of sufficient knowledge as to the merits and potentialities of the hybrid trees and also for some other reasons, the number of trees gradually decreased; these were hardly known to the public until the end of the 1990s.

The discovery of the hybrids was the result of a survey for tree resources of Shanghai carried out by Ye Zheng-Ji and his colleagues from 1998 to 2001. They have found that the 20–30 year-old F₁ hybrids—about 2000 in all—have proven to be very successful in Shanghai compared to *Taxodium distichum* (L.) Rich., *T. ascendens* Brongn., *Metasequoia glyptostroboides* Hu et Cheng, and *Cryptomeria fortunei* Hooibrenk ex Otto et Dietr. These hybrids are semi-evergreen, grow fast, hold up to strong winds, and thrive not only in ordinary garden soil but also in wetlands and saline sea-shores with a soil pH ranging from 6.5 to 8.6. The trees can grow in saline soil with 0.4% salt. A small plantation of the hybrids was seen growing well in a lake in Songjiang. These data are congruent with the statements that hybrids sometimes respond better than their parents (Stebbins 1969) and that they may show new characters not present in either parent (Knobloch 1972). The stand of hybrids in Chuansha Tree Nursery, the largest one in Shanghai—with about 1500 individuals covering an area of about 1.8 ha.—was designated “The Protected Forest of Germplasm Resources of Shanghai” by the municipal authorities in 2001. These trees are 30–40 cm. in diameter at breast-height, and the largest is about 62.5 cm. in diameter. The hybrid species is useful for landscape planting as well as for large-scale windbreaks in the riverine and coastal regions of Shanghai and neighboring provinces. Since the climatic and edaphic conditions (the more or less alkaline soil and the high groundwater level) in Shanghai are not very favorable for growing many kinds

of trees, these new hybrids are bound to play an important role in the rapid development of gardening and urban forestry in the city.

\times **Taxodiomeria peizhongii** Z.J. Ye, J.J. Zhang et S.H. Pan, gen. et sp. nov. (**Figs. 12, 13**). *Taxodium mucronatum* Ten. (♀) and *Cryptomeria fortunei* Hooibrenk ex Otto et Dietr. (♂). TYPE: CHINA. SHANGHAI: Jinshan, Jinshan General Petrochemical Works, cultivated tree more than 20 m high, diameter breast-height ca. 50 cm, bearing juvenile male strobili, strips of bark transversely fissured, 25 Sep 2001, S.H. Pan 01563A (HOLOTYPE: PE; ISOTYPES: NAS, SHM).

Haec species hybrida speciei materno *Taxodio mucronato* Ten. valde similis, a quo praecipue differt planta ut in specie paterno sine geniculis et anteridibus etiam crescenti in terra humida, trunco integro nec dilatato ad basin et plerumque in summo altitudinem 5–8 metrorum duobus pluribusve ramulis primariis diviso raro recto et simplice, corticis schedis longis angustisque saepe transversaliter fissuratis tecto, et surculis multis in ramulis primariis vel etiam in trunco instructa. Strobili a nobis non visi praeter plantis singulis ex Jinshanensi in autumnum amentis masc. immaturis 6–12 cm longis secus ramulos hornotinos dispositis paniculam pendulam formantibus instructis. Strobili masc. immaturi unusquisque 6 staminibus praediti.

In cultura in solo usitato horti et in terris humidis et etiam in littoribus salsis.

PARATYPE: **CHINA. Shanghai:** Songjiang, Zuibaichi Park, cultivated, 21 Sep 2001, S.H. Pan 01540 (SHM); Pudong, Yangjing Nursery, cultivated, in flooded ground, 12 Aug 2001, S.H. Pan 01275A (FUS); Shanghai, Pudong, Chuansha Tree Nursery, in a stand along the coast, 1 Sep 2001, S.H. Pan 01400 (SHM).

The specific epithet *peizhongii* honors Prof. Ye Pei-Zhong of the former Nanjing Forestry College, who made this hybrid by crossing *Taxodium mucronatum* (♀) and *Cryptomeria fortunei* (♂).

This hybrid species resembles the maternal species *Taxodium mucronatum* Ten. in the spirally arranged, drooping, annual leafy shoots that drop shortly before the new shoots leaf out in spring and in having closely arranged, distichous, short (<1cm long) leaves (Fig. 11). The phenomenon of matro-clinal inheritance of the hybrids has recently been confirmed by RAPD analysis (Chen et al. 2002). This report has shown that the genetic distance of the hybrids from *T. mucronatum* (0.210–0.246) is much shorter than that of the hybrids from *Cryptomeria fortunei*, their paternal species (0.757–0.764). Morphologically, the hybrid differs from the maternal species chiefly in a few significant characters. It does not have butswells (knee-like growths) and buttresses (as in the paternal species), the trunk is usually divided at a height of 5–8 m into two or more primary branches and, consequently, the crown has forms such as conical, cylindrical, ellipsoid, and pyriform, etc., all of them being more or less round-topped. Rarely is the trunk straight and undivided. The narrow, long strips of bark are usually transversely fissured. There are many shoots on the primary branches or even on the trunk.

Buttresses and butswells are characteristic of the genus *Taxodium* (Harrison 1966; Hart & Price 1990), though butswells are only occasionally seen in *T. mucronatum* (Hart & Price 1990; Martinez 1950), and their presence depends to a great extent on the environmental conditions in which the plants grow (Kurz



FIG. 1. Base of the trunk of \times *Taxodiomeria peizhongii* growing in Chuansha Tree Nursery, Shanghai, showing lack of buttresses.

FIG. 2. Base of the trunk of *Taxodium mucronatum* Ten. (maternal plant of the hybrid) cultivated in the campus of Dongnan University, Nanjing, showing the buttresses.

FIG. 3. Base of the trunk of *Taxodium mucronatum* Ten. growing in Giant Park of Washington, D.C. The photo was taken in September 2002 when the fifth author of this paper was visiting the United States.



FIG. 4. Close shot of the bark of \times *Taxodiomeria peizhongii* growing in Chuansha Tree Nursery, Shanghai, showing the transversely fissured strips.

FIG. 5. Close shot of the bark of \times *Taxodiomeria peizhongii* growing in Chuansha Tree Nursery, Shanghai, showing the transversely fissured strips.

FIG. 6. Close shot of the lower part of \times *Taxodiomeria peizhongii* growing in Chuansha Tree Nursery, Shanghai, showing the divided trunk.

FIG. 7. Individuals of \times *Taxodiomeria peizhongii* growing in Yangjing Tree Nursery, Shanghai, showing the divided trunks.



FIG. 8. Two individuals of *Taxodiomeria peizhongii* growing in Yangjing Tree Nursery, Shanghai, showing the divided trunks.

FIG. 9. *Taxodiomeria peizhongii* in Chuansha Tree Nursery, Shanghai.

FIG. 10. *Taxodiomeria peizhongii* in a residential quarter near Yangjing Tree Nursery, Shanghai.

FIG. 11. Close shot of a leafy branch and branchlets of *Taxodiomeria peizhongii* growing in Yangjing Tree Nursery, Shanghai.



FIG. 12. Close shot of branchlets with male strobili of \times *Taxodiomeria peizhongii* taken from the type specimen tree cultivated in Jinshan, Shanghai.

FIG. 13. Holotype of \times *Taxodiomeria peizhongii*.

& Demaree 1934). In the present hybrid species, however, the trunk is integral and buttresses and butswells have never been seen even in plants growing either in wetlands or in seasonally flooded lowlands. Thus, it can be seen that there is a difference between the hybrid species and *Taxodium mucronatum* concerning the presence or absence of butswells or buttresses.

It seems that different tree forms have something to do with age in *Taxodium*, from columnar, to more conical, and to flat topped (J. Li, pers. comm. 2001). The hybrid trees are of conical habit when young but develop a wide and often flattened crown when old (Harrison 1966; Hart & Price 1990). But no matter how great the variation of the tree forms may be, the trees maintain their straight trunks and do not form double multiple leaders as do most of our hybrid trees.

Although the hybrids generally have no strobili, at least now, some individuals cultivated in Jinshan have been found to bear male catkins 6–12 cm long assembled into pendulous panicles on the present year's shoots in autumn [2002]. These immature male strobili possess six microsporophylls each and are expected to open in spring 2003.

KEY TO VEGETATIVE DIFFERENCES BETWEEN
 ×*TAXODIOMERIA PEIZHONGII* AND *TAXODIUM MUCRONATUM*

1. Base (trunks) of adult trees in either wetlands or in saline soil without buttresses (Fig. 1), butswells (knee-like growths) absent; long narrow strips of bark usually transversely fissured (Figs. 4, 5); tree usually divided at a height of 5–8 m into 2 or more primary branches (Figs. 6, 7, 8); crown with many different forms, conical, cylindrical, ellipsoid, pyriform, etc.—but with more or less a rounded top (Figs. 9, 10) _____ × ***Taxodiomeria peizhongii***
1. Base (trunks) of adult trees always with a swollen and often buttressed bases (Figs. 2, 3), butswells (knee-like growths) frequently present in flooded areas; long narrow strips of bark never transversely fissured; tree conical in habit when young, but developing a wide and often flattened crown when old _____ ***Taxodium mucronatum***

ACKNOWLEDGMENTS

We thank Li Jian-Hua and Peter Del Tredici of the Arnold Arboretum of Harvard University for their helpful suggestions and for sending us needed literature; Verne Grant, Barney L. Lipscomb, and John W. Thieret for offering suggestions for improvement; and Prof. Ni De-Xiang of Fudan University for his participation in our investigation and helpful comments.

REFERENCES

- ANONYMOUS. 1979. Silvicultural techniques for the principal trees in China. Agricultural Press, Beijing (in Chinese).
- CHEN, Y.P., S.H. PAN, J.J. ZHANG, W.J. ZHU, H.J. NIU, Z.C. QU, J.W. WANG, D.L. SHEN, and Z.J. YE. 2002. RAPD analysis of genetic relationships among the natural populations of hybrid *Taxodium mucronatum* Tenore. *J. Fudan Univ. (Nat. Sci.)* 41(6):641–645.
- HARRISON, S.G. 1966. A handbook of Coniferae and Ginkgoaceae. Edward Arnold Publishers Ltd., London.
- HART, J.A. and R.A. PRICE. 1990. The genera of Cupressaceae (including Taxodiaceae) in the southeastern United States. *J. Arnold Arbor.* 71:275–322.
- KNOBLOCH, I.M. 1972. Intergeneric hybridization in flowering plants. *Taxon* 21:97–103.
- KURZ, H. and D. DEMAREE. 1934. Cypress buttresses and knees in relation to water and air. *Ecology* 15:36–41.
- MARTINEZ, M. 1950. El ahuchete (*Taxodium mucronatum* Ten.). *Anales Inst. Biol. Mexico* 21:25–82.
- MIAO, M.Z., Z.Q. ZHANG, Y.C. FANG, and R.R. REN. 1982. The principal economical trees of Hunan. Hunan Science and Technology Publishers (in Chinese).
- STEBBINS, JR., G.L. 1969. The significance of hybridization for plant taxonomy. *Taxon* 18: 26–35.